

### Exp 3: Hardness test

Hardness: is Resistance to indentation or scratching.

Objective: To find Vicker Hardness # (VHN) for steel specimen

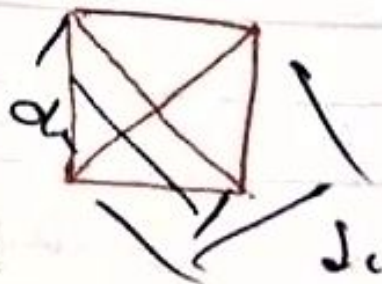
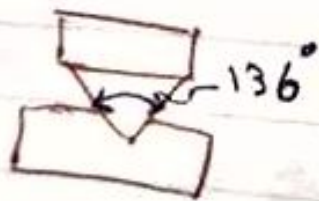
• observe relation between depth & Hardness #.

The smaller the indentation  $\rightarrow$  harder the material

Ductility of work piece is larger than ductility of Indenter

Pyramid shape Indenter

work piece



$$\checkmark VHN = 1.854 \frac{P}{d^2} \quad \text{local}$$

$$\checkmark d = \frac{d_1 + d_2}{(0.1)(2)} \quad \text{(Total magnification)}$$

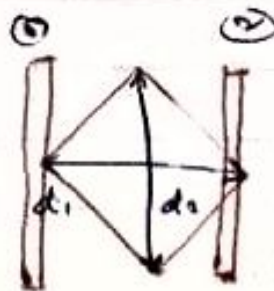
VHN  $\uparrow$   $\rightarrow$  Hardness  $\uparrow$

② Brinell

Indenter is sphere



\* Hardness the specimen grinded & polished no etching



(1)

load	$d_i$ (mm)	$d_e$ (mm)	$28.1 = \dots$
gf			
100	25	25	
200	38.5	38.5	$50 + 10$
500	65	68.5	$107.9 (2) (100)$
1000	99.5	96	

Stress

Strain

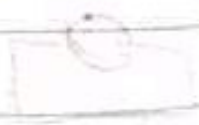
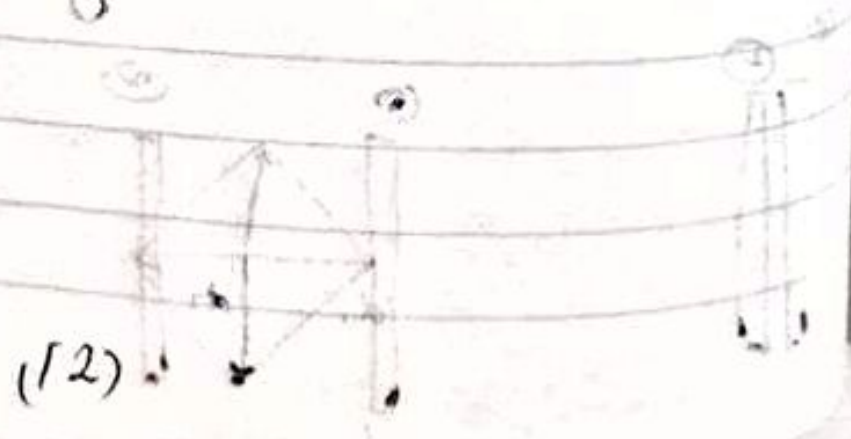


Diagram for stress-strain curve





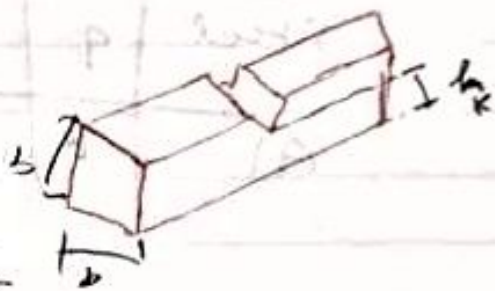
## Exp. (5). Impact Test

obj

1. Impact Energy.
2. Toughness.
3. ductile or Brittle.

$K$ : Impact energy.  $= mgh_u - mgh_f$

$$a_k = \frac{AK}{b h_k}$$



$a_k$ : Resistance to impact

$K$ : striking energy (Joule) /  $\text{Impact energy}$

$b$ : width of specimen.

$h_k$ : thickness from center of Notch. (mm)

ductile: deform Energy larger than  
Brittle.

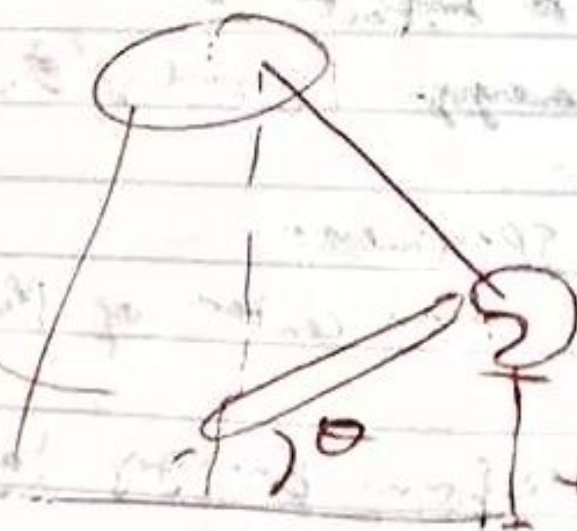
Brittle:

(3)

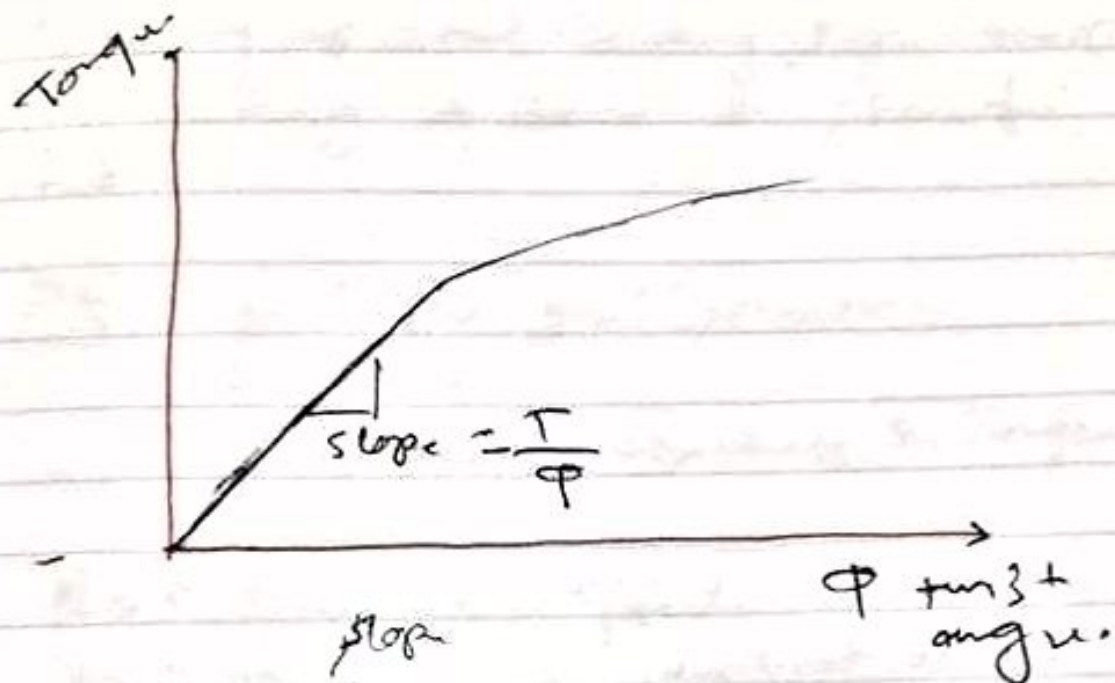
Notch equal  
Charpy: will  
Izod: Same.

when 2 or more bodies callow  
high face or shock Applied for  
Short Period of time.

	$b$ (in)	$l_x$ (in)	AK (J)
Steel	9	6	40
Al	6	4	12



## Exp. (5). Torsion Test.



①  $G = \frac{T}{\phi} \frac{l}{J}$   $\xrightarrow{\text{Spiral}}$

$G$  modulus of rigidity.

$$J = \frac{\pi}{2} R^4$$

② Max Shear stress.

(15)



## Exp 17: Heat Treatment.

Heating up steel a very high temp then cooling it down at specific rate

- Obj.
1. Refine grain structure
  2. Relieve
  3. Increase hardness & Toughness

Heat treatment effect. on Mech properties - some item (not all).

- It
1. hardness & Toughness
  2. Resistance to wear
  3. Shock.
  4. Tensile strength

Grain size decreasing.

Annealing  $\rightarrow$  Normalizing  $\rightarrow$  Quenching  
in oil  
in water

Hardness increasing

Q: What is the product of each heat process.

① Annealing  $\rightarrow$  cooling furnace  $\rightarrow$  coarse pearlite

② Normalizing  $\rightarrow$  cooling in Air  $\rightarrow$  fine pearlite

③ Quenching oil  $\rightarrow$  very fine pearlite  
in water  $\rightarrow$  martensite (hard)  
& Brinell  
fastest cooling rate & Hardness  
is high.

(1, 1, 7)



Types of HIT  
original

$d_1$

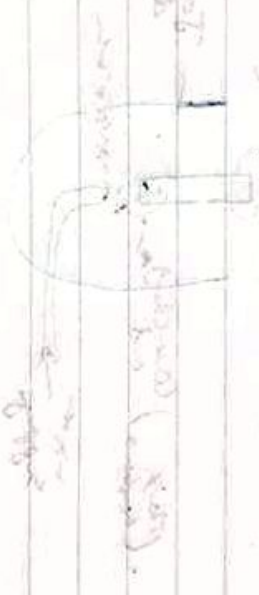
$d_2$

VHN  $f = 1500 \text{ Hz}$



Long cylinder  
(cross-section)

kinetic energy



vertical part is used to find out the  
(kinetic energy only) 330

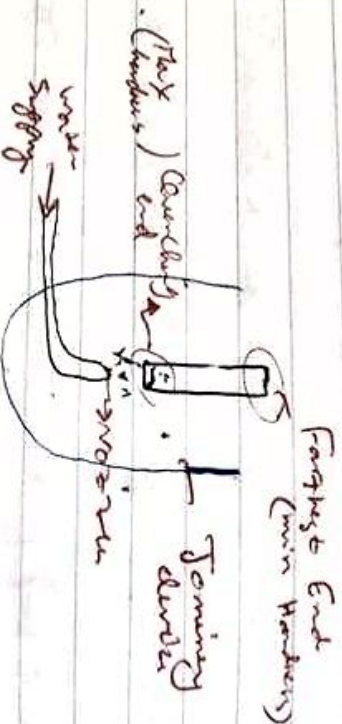
330 ft. long

(18)

# Hardability Test Exp. 8. (Jominy End Quench test)

Hardness: Resistance to scratching

Hardability: Measure the depth to which the specimen may be hardened.



by quenching it from a temp above  $A_{cc}$  (upper critical limit).  
expected  $727^{\circ}C$